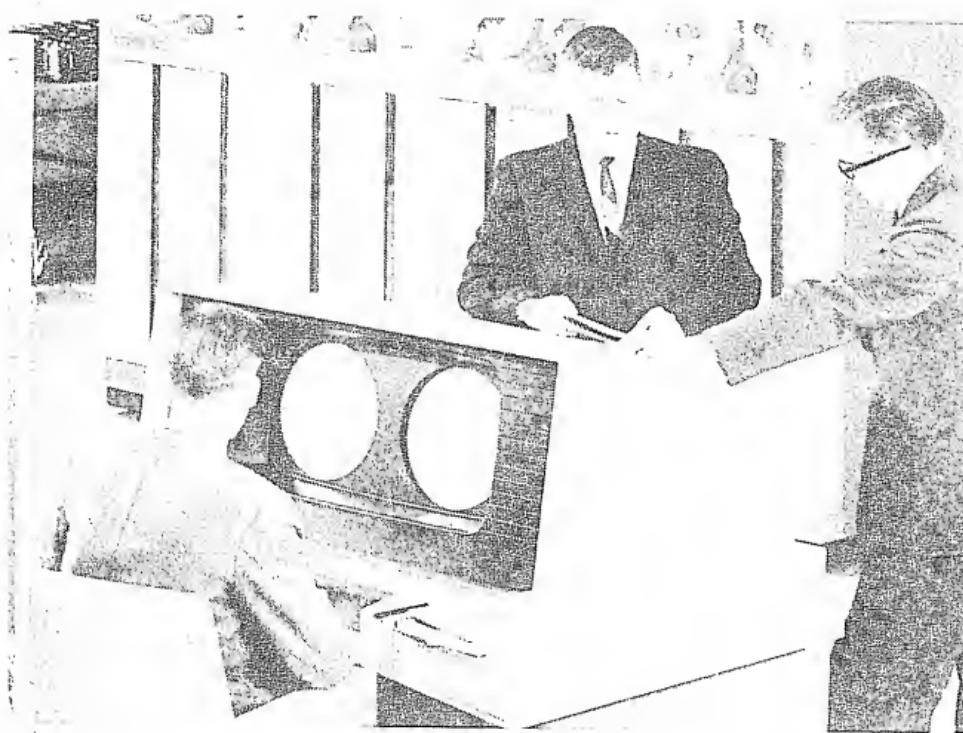


DAN C. LEE

2. 2. 70



INSTANT



2.3

FORTRAN

FORTRAN 2.3 provides a scientific language for programming under control of the SCOPE Operating System on Control Data 6000 series computers. FORTRAN is compatible with FORTRAN II, FORTRAN IV and FORTRAN VI languages.

Expressions and Statements

Arithmetic, logical, relational, and masking operations may be specified for the evaluation of expressions. Arithmetic expressions may contain any combination of arithmetic modes. Relational expressions contain arithmetic expressions separated by relational operators. Logical expressions may contain logical variables, logical constants, and relational expressions separated by logical operators. The masking expression is a generalized form of the logical expression in which the variables are of types other than logical.

Replacement statements may be arithmetic, logical and masking.

Variable and Function Types

Variable and function types may be implied as real or integer by the initial character or explicitly defined by a Type declaration as

COMPLEX	INTEGER
REAL	LOGICAL
DOUBLE or DOUBLE PRECISION	

Control Statements

Control statements alter sequential execution of statements, perform tests and iterations, and terminate subprograms.

GO TO	IF	PAUSE
DO	CONTINUE	END
	STOP	

Input/Output

Input/output statements permit the programmer to make use of computer efficiency with a complete range of input/output formats.

PRINT	BUFFER	WRITE
PUNCH		READ

Functions and Subprograms

Statements and statement sequences may be written as statement functions and as main programs, subroutines, and functions.

Library

The FORTRAN library provides a full set of mathematical and utility functions and subroutines.



FORTRAN PROGRAM EFFICIENCY HINTS

Same made variables and constants in an arithmetic expression

Reduced use of subscripts

Constant subscripts rather than variable

Arguments in common rather than calling list

Non-varying values computed before entering DO loop

Avoid function names as parameters in subprogram calling sequences

Limited use of logical made

FORTRAN ELEMENTS

Constants	Form	Examples
Integer	$n_1 n_2 \dots n_m$ $1 \leq m \leq 18$	2 247 314159265
Octol	$0n_1 \dots n_m$ $6 \leq m \leq 20$	777777700000000B
	$n_1 \dots n_m B$	O23146541 0000077
Reol	$n_1 n_2 \dots n_m E \pm \exp_{10}$ $1 \leq m \leq 15$	3.14 .0749 314.E05 .3E01
Double	$n_1 n_2 \dots n_m D \pm \exp_{10}$ $1 \leq m \leq 18$	37986324.3201D+01 3.1415D0
Complex	(r_1, r_2) real numbers r_1 = real part, r_2 = imaginary part	(1., 6.55) (-15., 16.7) (0., -1.)
Hollerith	$nHf_1 f_2 \dots f_n$ $1 \leq n \leq 10$ for o replacement statement $1 \leq n \leq 136$ for a format statement $1 \leq n \leq 1307$ for o DATA statement f_i alphanumeric character	7HGOGETIT 3HSON 5HTHANX
Logical	.TRUE. .T. or stored as .FALSE. .F.	all one bits all zero bits

Subscripts

For DIMENSION A(L,M,N) the location of A(i,j,k) with respect to first element of A is

$$A + (i-1 + L * (j-1 + M * (k-1))) * E$$

E is the number of words occupied by each element of A.

A subscript may be:

- Integer constant
- Simple integer variable
- Simple integer arithmetic expression

Examples:

- (I,J)
- (I+3, J+3, 2*K+1)
- (3*K*I+3)

Variables	Form	Examples
Simple integer	$a_1 a_2 \dots a_m$ $1 \leq m \leq 7$ $a_1 I, J, K, L, M, \text{or } N$ $a_2 - a_7$ Alphanumeric	N I2S04 M58
Simple real	$a_1 a_2 \dots a_m$ $1 \leq m \leq 7$ a_1 Alphabetic other than I,J,K,L,M,or N $a_2 - a_7$ Alphanumeric	VECTOR SPOILS A65
Subscripted integer	$a_1 a_2 \dots a_m (i, j, k)$ $1 \leq m \leq 7$ $a_1 I, J, K, L, M, \text{or } N$ $a_2 - a_7$ Alphanumeric	NERVE (6,8,6) LO (J) JEL (I,M,3)
Subscripted real	$a_1 a_2 \dots a_m (i, j, k)$ $1 \leq m \leq 7$ a_1 Alphabetic other than I,J,K,L,M,or N $a_2 - a_7$ Alphanumeric	TIMIE (J,K,L) QL (I) ROGER (2,2,1)

Variables defined by Type declarations begin with any letter.

FORTRAN STATEMENTS

A subprogram is compiled in one of two modes:

FORTRAN IV

FORTRAN II

Subprogram Statements

PROGRAM name (f_1, \dots, f_n)	{	Parameter list may be omitted
FORTRAN VI PROGRAM name (f_1, \dots, f_n)		
FORTRAN IV PROGRAM name (f_1, \dots, f_n)		
FORTRAN II PROGRAM name (f_1, \dots, f_n)		
SUBROUTINE name (p_1, \dots, p_m)		
FORTRAN VI SUBROUTINE name (p_1, \dots, p_m)		
FORTRAN IV SUBROUTINE name (p_1, \dots, p_m)		
FORTRAN II SUBROUTINE name (p_1, \dots, p_m)		
CALL name (p_1, \dots, p_m)		
$m \leq 60$ $n \leq 50$		
FUNCTION name (p_1, \dots, p_m)		
type FUNCTION name (p_1, \dots, p_m)		
FORTRAN VI FUNCTION name (p_1, \dots, p_m)		
FORTRAN VI type FUNCTION name (p_1, \dots, p_m)		
FORTRAN IV FUNCTION name (p_1, \dots, p_m)		
FORTRAN IV type FUNCTION name (p_1, \dots, p_m)		
FORTRAN II FUNCTION name (p_1, \dots, p_m)		
FORTRAN II type FUNCTION name (p_1, \dots, p_m)		
BLOCK DATA		
EXTERNAL name ₁ , name ₂ , ...		
RETURN		
ENTRY name		

Data Declaration and Storage Allocation Statements

COMPLEX list
DOUBLE list
DOUBLE PRECISION list
REAL list
INTEGER list
LOGICAL list
DIMENSION v₁,v₂,...,v_n
COMMON/l₁/list₁/l₂/list₂...
EQUIVALENCE (a₁,b₁,...),(o₂,b₂,...),...
DATA list₁/a₁,...,o_n/,list₂/b₁,...,b_n/,... or
DATA (list₃=c₁,...,c_n),(list₄=d₁,...,d_n),...

Statement Function

nome (p₁,...,p_n)=expression

Replacement Statements

o = Arithmetic expression

l = Logical expression

m = Masking expression

Control Statements

GO TO n

DO n i=m₁,m₂,m₃

GO TO i,(n₁,...,n_i)

CONTINUE

GO TO i

PAUSE

ASSIGN n to i

PAUSE n

GO TO (n₁,...,n_i),i

STOP

IF (o) n₁,n₂,n₃

STOP n

IF (l) s

END

IF (l) n₁,n₂

Format Statement and Specifications

FORMAT (spec₁,...,spec_n)

Spec_i

Ew.d Single precision floating point with exponent

Fw.d Single precision floating point without exponent

Dw.d Double precision floating point with exponent

Iw Decimal integer
 Rw Alphanumeric, right justified, leading zeros
 Ow Octal integer
 Aw Alphanumeric, left justified, with trailing blanks
 Lw Logical
 nP Scaling factor

Complex values are converted by a pair of consecutive Ew.d or Fw.d.

wX Intra-line spacing
 wH *...* { Heading and labeling, Hollerith characters
 / Begin new record

Printer Carriage Control

Character in first column	Resulting PRINT Operation
0	Double space before printing
1	Eject page before printing
+	Suppress spacing before printing
blank or other than above	Single space before printing

Input/Output and Data Transmission

READ (i,n) list	READ n, list
READ INPUT TAPE i,n,list	PRINT n, list
WRITE (i,n) list	PUNCH n, list
WRITE OUTPUT TAPE i,n,list	ENCODE (c,n,v) L
READ (i) list	DECODE (c,n,v) L
READ TAPE i,list	
WRITE (i) list	
WRITE TAPE i,list	
IF (EOF, i) n ₁ ,n ₂	
IF (ENDFILE i) n ₁ ,n ₂	
END FILE i	
REWIND i	
BACKSPACE i	
BUFFER IN (i,m) list	
BUFFER OUT (i,m) list	
IF (UNIT, i) n ₁ ,n ₂ ,n ₃ ,n ₄	
n ₁ Busy n ₃ EOF	
n ₂ Complete n ₄ Parity error	
NAMELIST /y ₁ /a ₁ /y ₂ /a ₂ /.../y _n /a _n	

FORTRAN FUNCTIONS

In-Line Functions

ABS(x)	Absolute value	Real to real
AIMAG(c)	Imaginary part of complex	Complex to real
AINTR(x)	Truncation, integer	Real to real
AMAX0(i ₁ ,i ₂ ,...)	Maximum argument	Integer to real
AMAX1(x ₁ ,x ₂ ,...)	Maximum argument	Real to real
AMIN0(i ₁ ,i ₂ ,...)	Minimum argument	Integer to real
AMIN1(x ₁ ,x ₂ ,...)	Minimum argument	Real to real
AMOD(x ₁ ,x ₂)	x ₁ modulo x ₂	Real to real
AND(x ₁ ,...,x _n)	Boolean AND of x ₁ ,...,x _n	Logical
CMPLX(x ₁ ,x ₂)	Real to complex (x ₁ + ix ₂)	Real to complex
COMPL(x)	Complement of x	Logical
CONJG(c)	Conjugate of c	Complex to complex
DIM(x ₁ ,x ₂)	If x ₁ > x ₂ :x ₁ -x ₂ If x ₁ ≤ x ₂ :0	Real to real
DMAX1(d ₁ ,d ₂ ,...)	Maximum argument	Double to double
DMIN1(d ₁ ,d ₂ ,...)	Minimum argument	Double to double
FLOAT(i)	Integer to real	Integer to real
IABS(i)	Absolute value	Integer to integer
IDIM(i ₁ ,i ₂)	If i ₁ > i ₂ :i ₁ -i ₂ If i ₁ ≤ i ₂ :0	Integer to integer
IFIX(x)	Real to integer	Real to integer

INT(x)	Truncation, integer	Real to integer
ISIGN(i ₁ , i ₂)	Sign of i ₂ times i ₁	Integer to integer
MAX0(i ₁ , i ₂ , ...)	Maximum argument	Integer to integer
MAX1(x ₁ , x ₂ , ...)	Maximum argument	Real to integer
MIN0(i ₁ , i ₂ , ...)	Minimum argument	Integer to integer
MIN1(x ₁ , x ₂ , ...)	Minimum argument	Real to real
MOD(i ₁ , i ₂)	i ₁ modulo i ₂	Integer to integer
OR(x ₁ , ..., x _n)	Boolean OR of x ₁ , ..., x _n	Logical
REAL(c)	Real part of complex	Complex to real
SIGN(x ₁ , x ₂)	Sign of x ₂ times x ₁	Real to real

Library Functions

ACOS(x)	Arccosine	Real to real
ALOG(x)	Natural log of x	Real to real
ALOG10(x)	Log to the base 10 of x	Real to real
ASIN(x)	Arcsine	Real to real
ATAN(x)	Arctangent x radians	Real to real
ATAN2(x ₁ , x ₂)	Arctangent x ₁ /x ₂	Real to real
CABS(c)	Absolute value	Complex to real
CCOS(c)	Complex cosine	Complex to complex
CEXP(c)	Complex exponent	Complex to complex
CLOG(c)	Complex log	Complex to complex
COS(x)	Cosine x radians	Real to real
CSIN(c)	Complex sine	Complex to complex
CSQRT(c)	Complex square root	Complex to complex
DABS(d)	Absolute value	Double to real

DATAN(d)	Double arctangent	Double to double
DATAN2(d ₁ ,d ₂)	Double arctangent: d ₁ /d ₂	Double to double
DBLE(x)	Real to double	Real to double
DCOS(d)	Double cosine	Double to double
DEXP(d)	Double exponent	Double to double
DLOG(d)	Natural log of d	Double to double
DLOG10(d)	Log to base 10 of d	Double to double
DMOD(d)	d ₁ modulo d ₂	Double to double
DSIGN(d ₁ ,d ₂)	Sign of: d ₂ times d ₁ in absolute value	Double to double
DSIN(d)	Sine of double precision argument	Double to double
DSQRT(d)	Square root of double	Double to double
EXP(x)	e to xth power	Real to real
IDINT(d)	Double to integer	Double to integer
LEGVAR(o)	Returns -1 if o indefinite, +1 if o out of range, 0 if o normal	Real to integer
LENGTH(i)	Number of words read on unit i after BUFFER IN	Integer to integer
RANF(i)	Random number generator	Integer to real
SGNL(d)	Double to real (unrounded)	Double to real
SIN(x)	Sine x radians	Real to real
SQRT(x)	Square root of x	Real to real
TAN(x)	Tangent x radians	Real to real
TANH(x)	Hyperbolic tangent x radians	Real to real
LOCF(o)	Address of argument o	Integer
XLOCF(o)	Address of argument o	Integer

LIBRARY SUBROUTINE

DISPLA (nH nome, nome)	DISPLAY NAME AND VALUE
n ≤ 7	
DUMP	DUMP STORAGE
PDUMP (o ₁ ,b ₁ ,f ₁ ,...,o _n ,b _n ,f _n)	
o _i	First word of area to be dumped
b _i	Last word of area to be dumped
f _i	Dump format indicators: 0 or 3 is octal dump 1 is real dump 2 is integer dump
DVCHK (j)	DIVISION BY ZERO TEST
j=1 if occurred	
j=2 if not	
FTNBIN(1,n,IRAY)	BINARY BLOCKING OF I/O
READEC(cm,ecs,n)	TRANSFERS WORDS FROM ECS TO CENTRAL MEMORY
WRITEC(cm,ecs,n)	TRANSFERS WORDS FROM CENTRAL MEMORY TO ECS
OPENMS(u,ix,1,p)	OPENS MASS STORAGE FILE
READMS(u,fwo,n,i)	TRANSFERS DATA FROM MASS STORAGE FILE
WRITMS(u,fwo,n,i)	TRANSFERS DATA TO MASS STORAGE FILE
STINDX(u,ix,1)	CHANGES THE FILE INDEX
EXIT	TERMINATE EXECUTION
OVERFL (j)	OVERFLOW TEST
j=1 if occurred	
j=2 if not	
REMARK (nH...)	MESSAGE TO SYSTEM DAYFII
Displays it on the console display. nH indicates n hollerith characters in the remark; n ≤ 40	
SECOND(i)	TIME IN SECONDS FROM DEADSTART

SLITE (i)	TURN ON SENSE LIGHT I
SLITET (i,j)	TEST SENSE LIGHT I
	j=1 if on
	j=2 if off
SSWTCH (i,j)	TEST SENSE SWITCH I
	j=1 if down
	j=2 if up
SEGMENT(fn,e,o,lib,m)	LOAD RELOCATABLE SEGMENT
fn	Variable name of location containing left-justified display code file name to be loaded
e	Segment load level, 00-77 ₈
a	Simple or subscripted variable array name containing list of segments, sections, subprograms to be loaded
lib	Load unsatisfied externals from system library if zero or blank
m	Do not print map of segment load if zero or blank
OVERLAY(fn,l ₁ ,l ₂ ,p)	LOAD ABSOLUTE OVERLAY
fn	Variable name of location containing left-justified display code file name to be loaded
l ₁	Primary overlay level
l ₂	Secondary overlay level
p	If 6HRECALL, overlay is not reloaded if already in memory

FORTRAN VI DIFFERENCES

END statement in function or subroutine acts as RETURN

DO loop not executed if initial value exceeds terminal value

FORTRAN II AND FORTRAN IV SUBPROGRAMS

Column 1 Indicators

D	Dauble precision mode replacement
I	Complex mode replacement
B	Masking replacement
F	EXTERNAL

FORTRAN II statements which contain a B in column 1 (Boolean) are evaluated as masking expressions. The aperator equivalences are:

FORTRAN	FORTRAN II
.AND.	*
.NOT.	-
.OR.	+
	/

Statements

IF (I)₁,₂

If I is a variable, the true branch is taken only if the value af I is negative.

SENSE LIGHT i

i must be integer constant

IF (SENSE LIGHT i)₁,₂

i must be integer constant

IF (SENSE SWITCH i)₁,₂

i must be integer constant

IF DIVIDE CHECK ₁,₂

IF QUOTIENT OVERFLOW ₁,₂

IF ACCUMULATOR OVERFLOW ₁,₂

FORTRAN II Mode Subprogram Only

EQUIVALENCE may re-order COMMON.

Function names must end with F and be 4-7 characters.

Function names must begin with X if the value is integer and any other alphabetic character if the value is real.

CHARACTER CODES

Character	External Code	Console Display Code	Punch Card
A	61	01	12,1
B	62	02	12,2
C	63	03	12,3
D	64	04	12,4
E	65	05	12,5
F	66	06	12,6
G	67	07	12,7
H	70	10	12,8
I	71	11	12,9
J	41	12	11,1
K	42	13	11,2
L	43	14	11,3
M	44	15	11,4
N	45	16	11,5
O	46	17	11,6
P	47	20	11,7
Q	50	21	11,8
R	51	22	11,9
S	22	23	0,2
T	23	24	0,3
U	24	25	0,4
V	25	26	0,5
W	26	27	0,6
X	27	30	0,7
Y	30	31	0,8
Z	31	32	0,9
0	12	33	0
1	01	34	1
2	02	35	2
3	03	36	3
4	04	37	4
5	05	40	5
6	06	41	6
7	07	42	7
8	10	43	8
9	11	44	9
/	21	50	0,1
+	60	45	12
-	40	46	11
blank	20	55	space
.	73	57	12,8,3
)	74	52	12,8,4
\$	53	53	11,8,3
*	54	47	11,8,4
,	33	56	0,8,3
		:	

(34	51	0,8,4
=	13	54	8,3
≡	36	60	0,8,6
[17	61	8,7
]	32	62	0,8,2
:	00	63	8,2
≠	14	64	8,4
→	35	65	0,8,5
∨	52	66	11,0
^	37	67	0,8,7
↑	55	70	11,8,5
↓	56	71	11,8,6
<	72	72	12,0
>	57	73	11,8,7
≤	15	74	8,5
≥	75	75	12,8,5
⌈	76	76	12,8,6

; , character 77, is restricted in FORTRAN



FORTRAN CODING FORM



PROGRAM		NAME		DATE	PAGE
ROUTINE					
STATE- MENT NO.	FORTRAN STATEMENT				VERBAL NUMBER
	1-1000	11-999	2-1000	21-999	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					
51					
52					
53					
54					
55					
56					
57					
58					
59					
60					
61					
62					
63					
64					
65					
66					
67					
68					
69					
70					
71					
72					
73					
74					
75					
76					
77					
78					
79					
80					
81					
82					
83					
84					
85					
86					
87					
88					
89					
90					
91					
92					
93					
94					
95					
96					
97					
98					
99					
100					

Each line of a FORTRAN coding form represents the four fields of a punched card.

<u>Field</u>	<u>Columns</u>
Statement Number	1-5
Continuation	6
Statement	7-72
Identification	73-80

Statements may be identified by an integer from 1 through 99999. If o S, C or * appears in column 1, the remainder of the card is ignored by the compiler, but printed with the source listing as a comment.

A S may be used to separate multiple statements on a card. However, DATA and FORMAT statements cannot appear on a card separated in this manner.

A punch other than zero in column 6 identifies a card as a continuation of the statement from the preceding card.

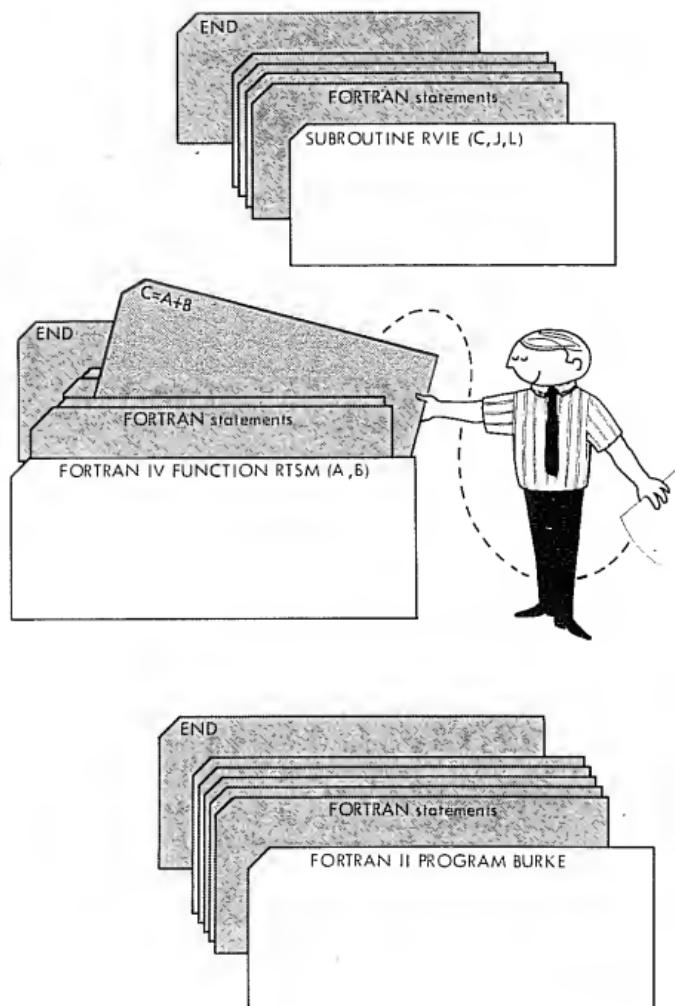
A statement is written in columns 7 through 72; blanks are ignored.

Columns 73-80 may contain identification and serial numbers. These columns are ignored, but printed with the program listing.

The entire 80 columns may be used for data input.

A period in column 1 signals page eject.

FORTRAN SOURCE DECK



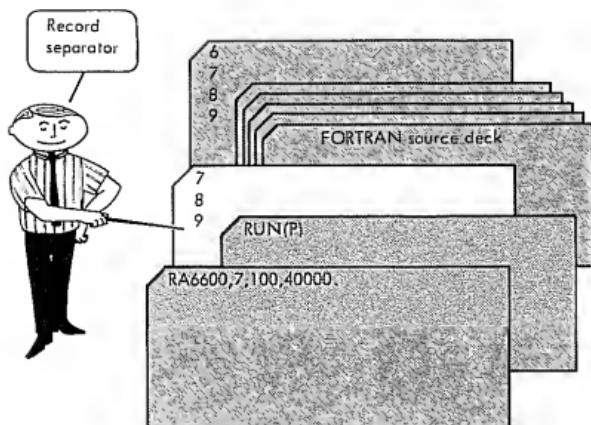
FORTRAN CONTROL CARD

RUN(cm,fl,bl,if,of,rf,lc,os,cs)

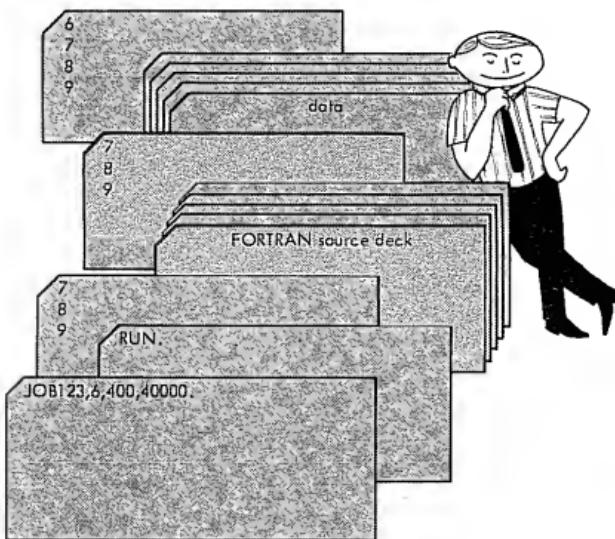
- cm Compiler mode option; if omitted, assume G; if unrecognized, assume S.
 - G Compile and execute, nolist unless explicit LIST cards appear in the deck
 - S Compile with source list, no execute
 - P Compile with source list and punch deck on file PUNCHB, no execute
 - L Compile with source and object list, no execute
 - M Compile with source and object list, produce a punch deck on file PUNCHB, no execute
- fl Object program field length; if omitted, it is set equal to the field length at compile time.
- bl Object program I/O buffer length; if omitted, assumed to be 2023B.
- if File name for compiler input; if omitted assumed to be INPUT.
- of File name for compiler output; if omitted, assumed to be OUTPUT.
- rf File name on which the binary information is always written; if omitted, assumed to be LGO.
- lc Line-limit (octal) on the OUTPUT file of an object program. If omitted, assumed to be 100008. If the line count exceeds the specified line limit, the job is terminated.
- os If non-zero or non-blank, the ASA switch causes the ASA I/O list/format interaction at execution time. It has no effect on the compilation method.
- cs Cross-reference switch; if non-zero a cross reference listing is produced.

If parameter list is omitted, RUN must be followed by a period.

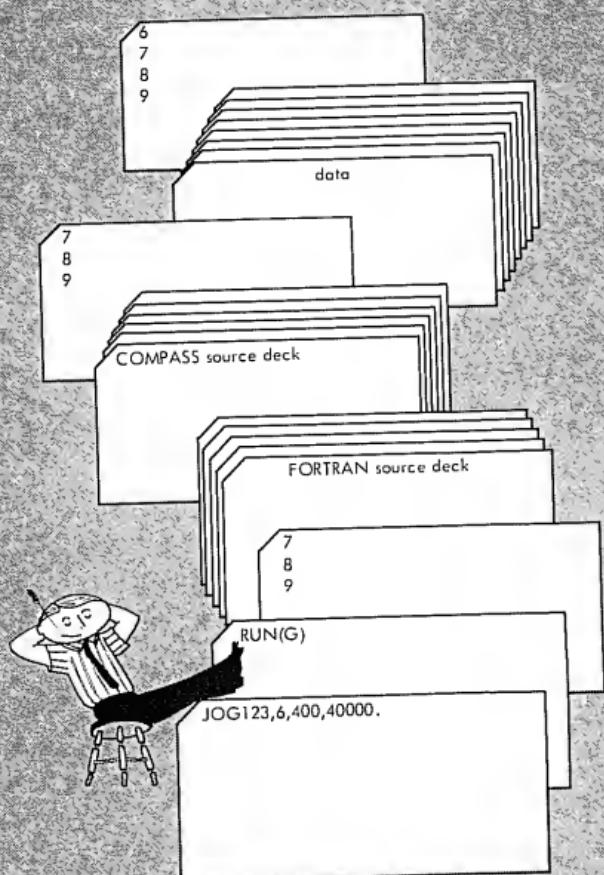
FORTRAN COMPILATION



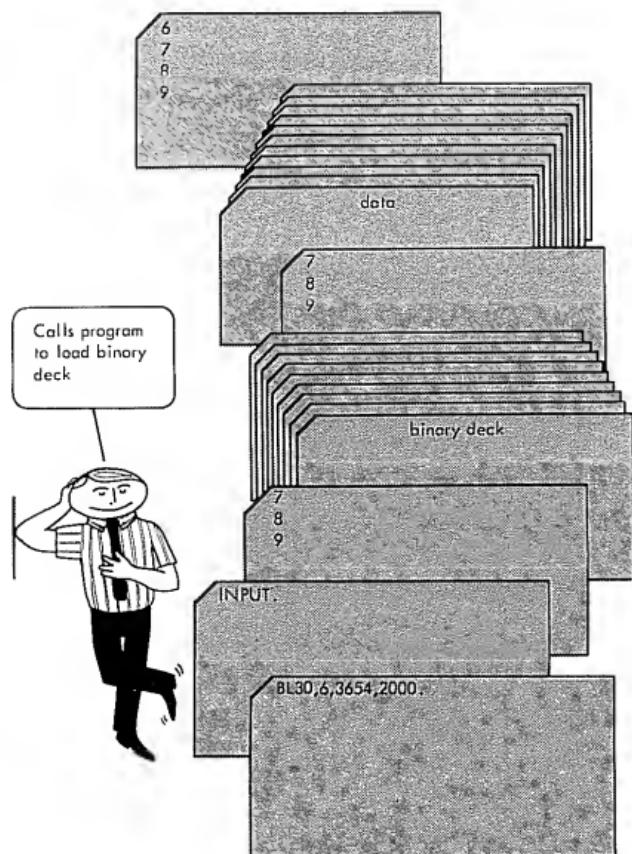
FORTRAN COMPILATION AND EXECUTION



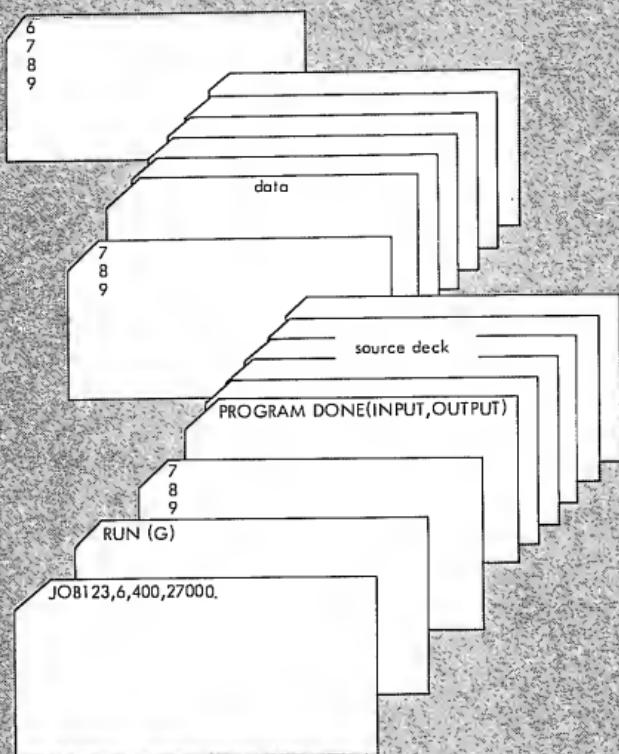
FORTRAN COMPILE, COMPASS ASSEMBLY AND EXECUTION



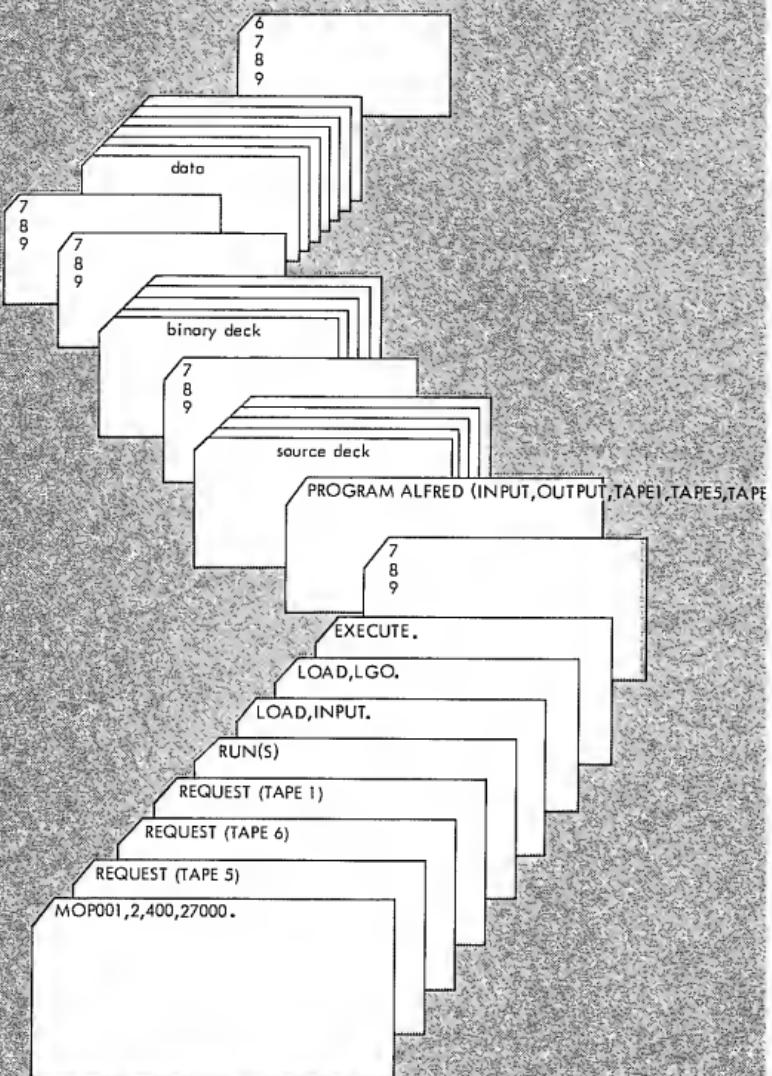
EXECUTION WITH BINARY DECKS



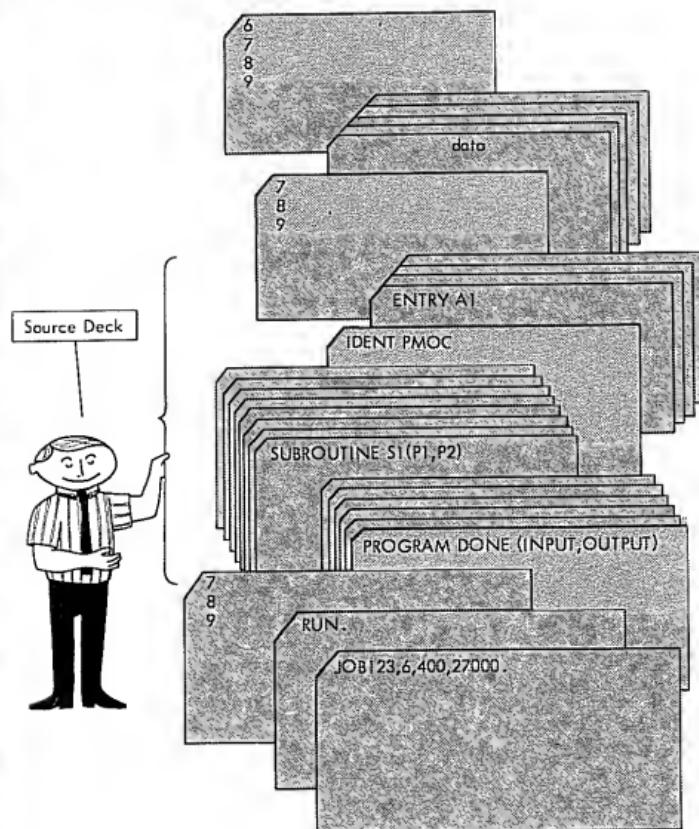
FORTRAN COMPILE AND EXECUTE



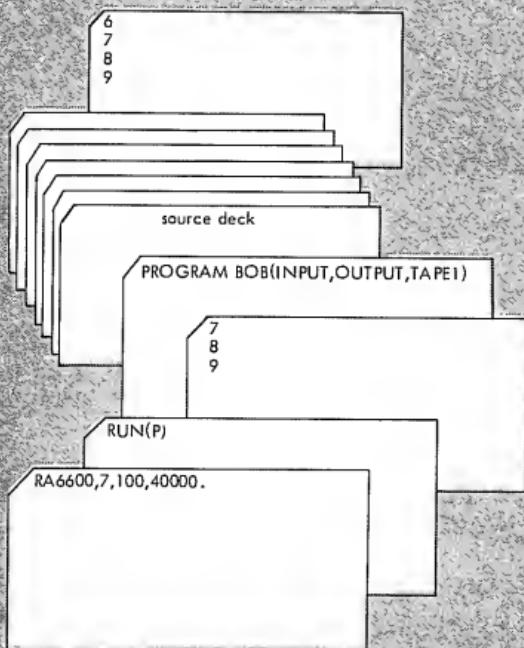
FORTRAN COMPILE AND EXECUTE



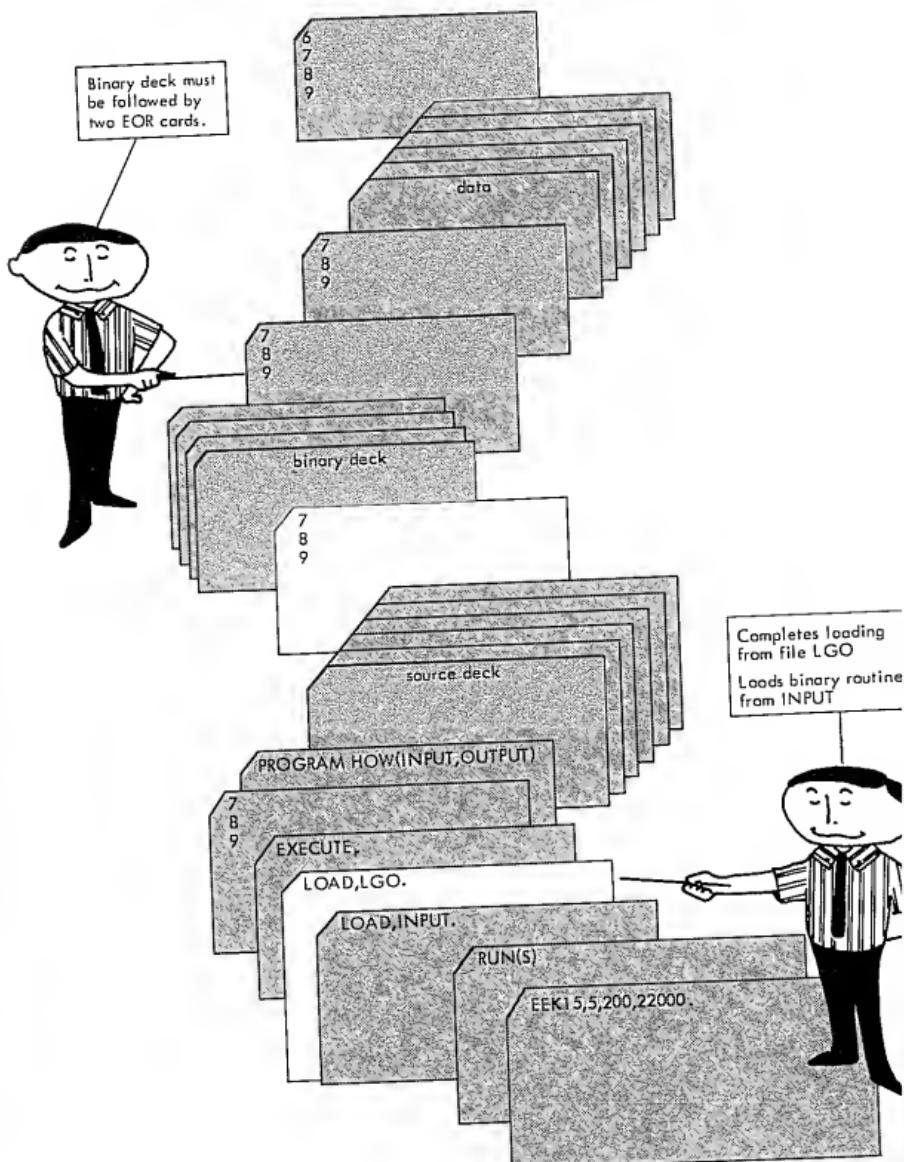
FORTRAN COMPILE AND EXECUTE WITH MIXED DECK



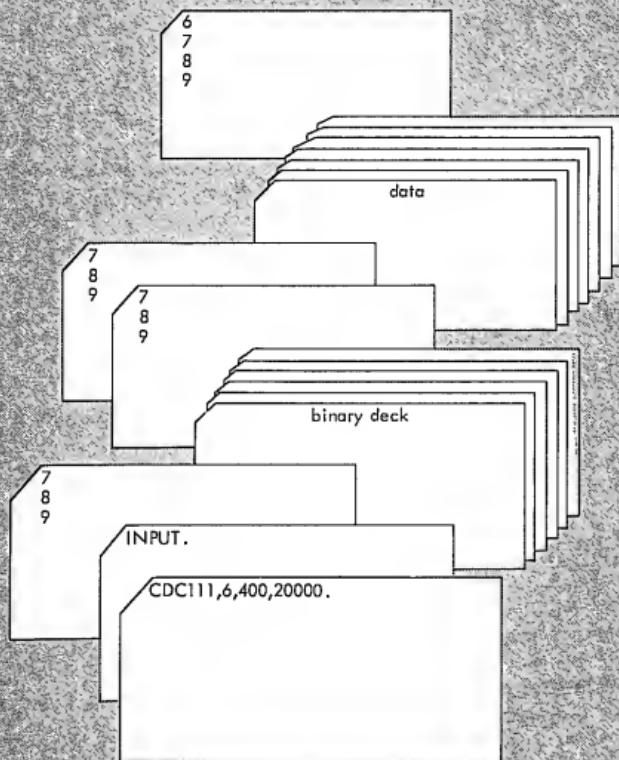
FORTRAN COMPILE AND PRODUCE BINARY CARDS



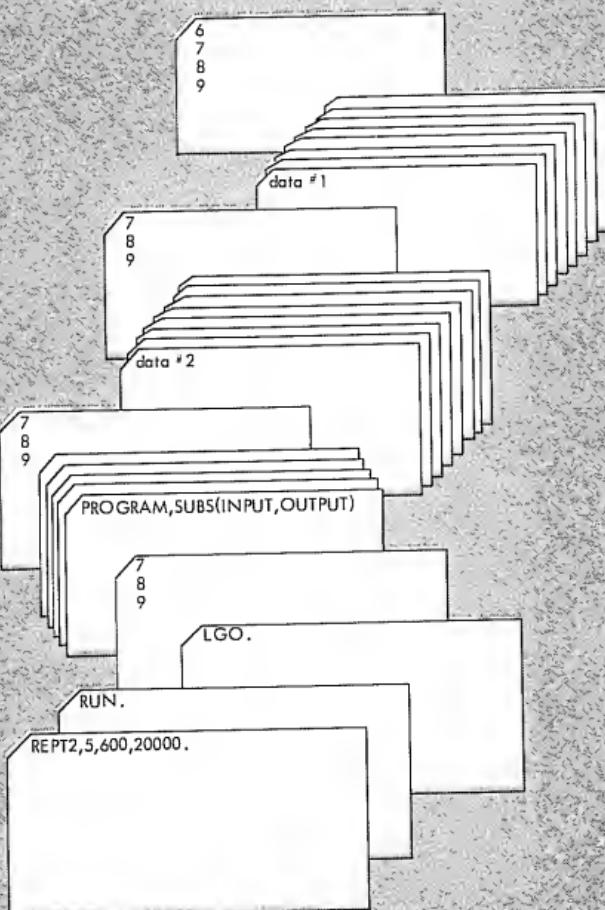
FORTRAN COMPILE AND EXECUTE



LOAD AND EXECUTE BINARY PROGRAM



COMPILE ONCE AND EXECUTE WITH DIFFERENT DATA DECKS



OVERLAY AND SEGMENT CONTROL CARDS

SEGMENT (sn, pn₁, pn₂, ..., pn_n) SEGMENT DEFINITIONS

sn Segment name to write on

pn_i Subprogram or section name

SEGZERO(sn, pn₁, pn₂, ..., pn_n) FIRST SEGMENT DEFINITION

sn Segment name to write on

pn_i Subprogram or section name

SECTION(sn, pn₁, pn₂, ..., pn_n) SECTION DEFINITION

sn Section name to write on

pn_i Subprogram name

OVERLAY(fn, l₁, l₂, cnnnnnnn) OVERLAY DEFINITION

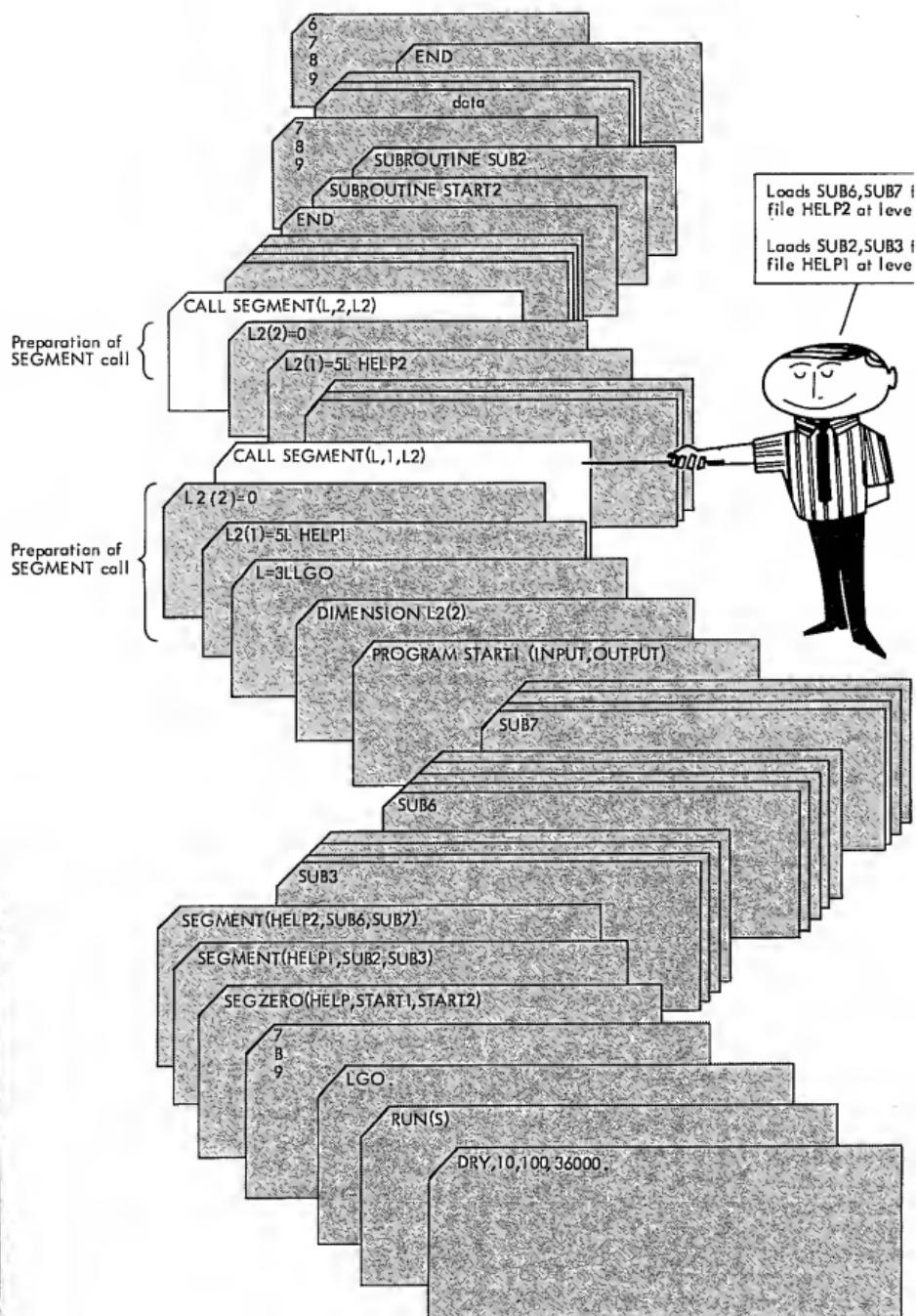
fn File name to write on; may be omitted after first,
if same file

l₁ Primary level number; 0 for first overlay card

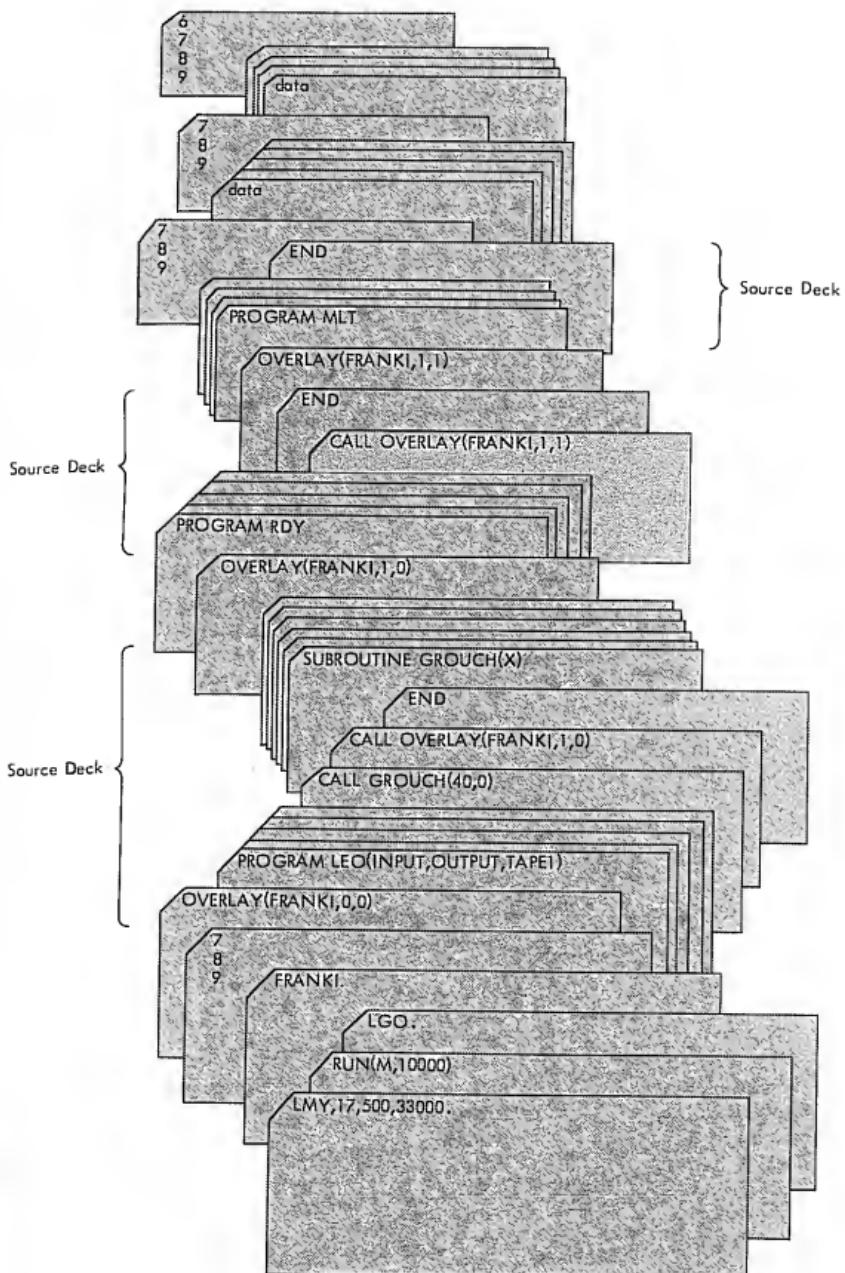
l₂ Secondary level number; 0 for first overlay card

cnnnnnnn Optional: load overlay nnnnnnnn₈ words from start of
blank common

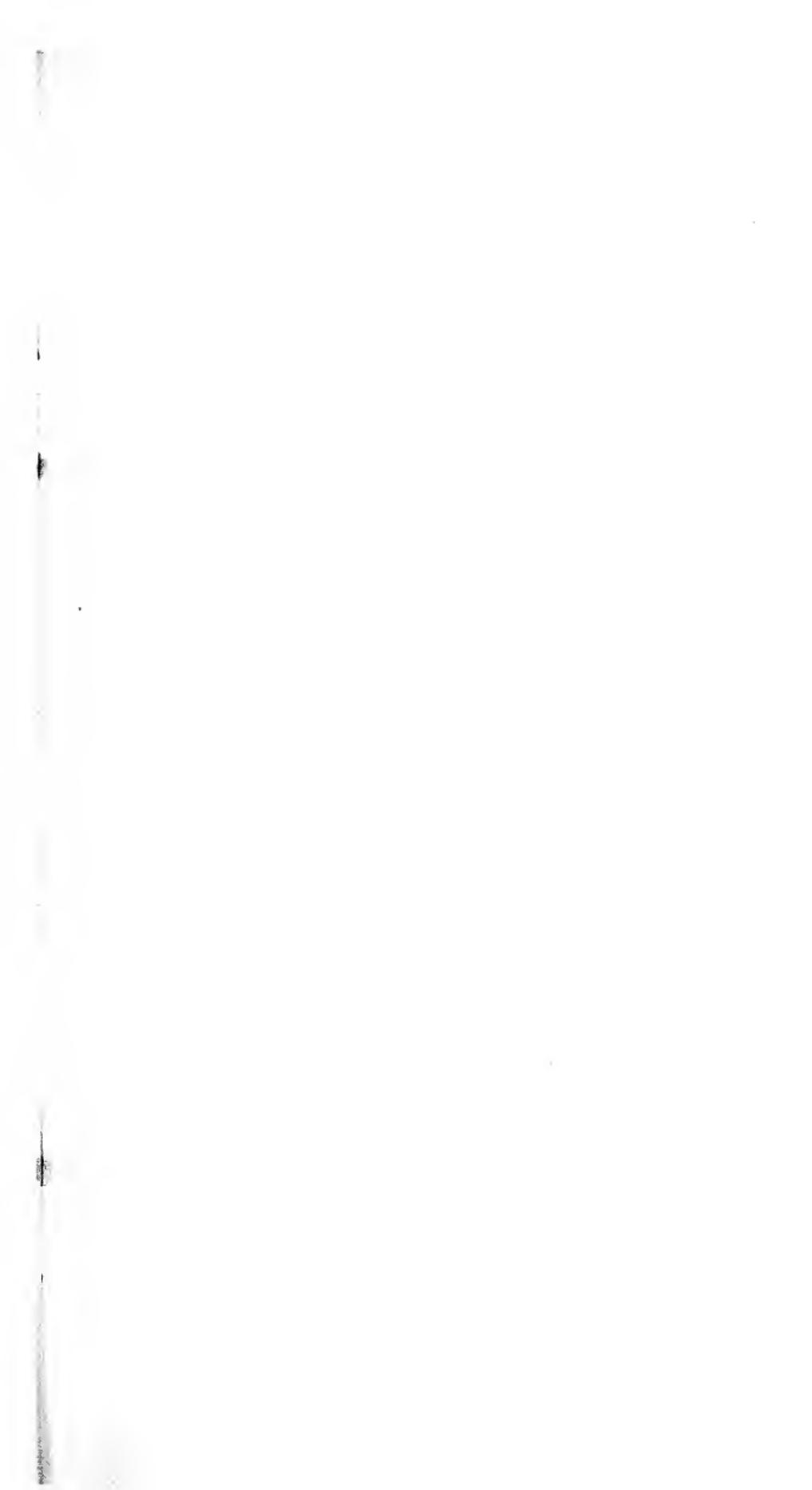
FORTRAN LOAD AND EXECUTE SEGMENTS



OVERLAY PREPARATION OF 0,0; 1,0; AND 1,1



NOTES



CONTROL DATA
CORPORATION

60189500D ©CONTROL DATA CORPORATION Printed in U.S.A.
MAY 1969